Chapter 1

INTRODUCTION

1.1 PURPOSE AND SCOPE

The cleanup of sites in the U.S. that are contaminated with radioactive material and the decommissioning of nuclear facilities are expected to generate large amounts of scrap metal. In fact, some sites controlled by the U.S. Department of Energy (DOE) have already accumulated significant inventories of scrap metal that are currently in storage awaiting final disposition. The Office of Radiation and Indoor Air of the U.S. Environmental Protection Agency is evaluating a broad range of technical and regulatory issues associated with the disposition of scrap metal from nuclear facilities. The Agency is examining alternatives to disposing of the scrap at a licensed low level radioactive waste disposal facility or otherwise maintaining the material under regulatory control.

This report is not a Regulatory Impact Analysis nor an Environmental Impacts Statement supporting an Agency rulemaking. It is intended solely as part of a technical information document for use by the Agency as part of the basis for decision-making with respect to the free release of metal from nuclear facilities. A separate document, "Radiation Protection Standards for Scrap Metal: Preliminary Cost-Benefit Analysis" (IEC 1997), describes a preliminary analysis of the potential costs and benefits of recycling scrap metal from nuclear facilities.

The purpose of the present analysis is to assess the radiological impacts of the free release of scrap metal from nuclear facilities on reasonably maximally exposed (RME) individuals. (Throughout this report, the terms "residually radioactive scrap metal," "residually contaminated scrap metal," "scrap metal from nuclear facilities," or simply "scrap metal" are used to refer to any metal that has the potential for free release. "Free release," in turn, refers to the clearance of the material from the regulatory control of DOE, the U.S. Nuclear Regulatory Commission (NRC) or the Department of Defense.) These radiological impacts are stated as doses or risks from one year of exposure, normalized to unit specific activities[1] (i.e., 1 pCi/g or 1 Bq/g in scrap)

[1] Throughout this report, the terms "radionuclide concentration" and "specific activity" may appear to be used interchangeably. Strictly speaking, concentration refers to a given physical quantity, such as mass, per unit volume or unit mass of the matrix. The concentration of uranium in soil, for example, might be expressed in micrograms of uranium per gram of material. Specific activity is always expressed in units of activity per unit mass, such as pCi/g or Bq/g. For a given radionuclide, of course, the specific activity is proportional to its concentration. Since radionuclides are usually

of each separate radionuclide or combination of nuclides that is a potential contaminant of scrap metal. The relationship between the concentration of a radionuclide in scrap metal and the potential radiological impacts on RME individuals are intended to help EPA establish clearance levels for the free release of scrap metal from nuclear facilities that are in the Agency's acceptable risk range, should the Agency decide to issue rules or guidance which establishes such levels. The present report does *not* address the issues related to the implementation of any such rules. Thus, it would be incorrect to predict the numerical values of any future clearance criteria solely on the basis of the present analysis.

The analysis addresses metal that is suspected to be lightly or moderately contaminated as a result of radioactive deposition or neutron activation. Scrap metal that has never been exposed to possible radioactive contamination is not considered in the evaluation. Conversely, metal that is so heavily contaminated that it can only be disposed of as a radioactive waste is also excluded from this evaluation.

1.2 ORGANIZATION OF THE REPORT

The report comprises three volumes. The first volume consists of nine chapters. Chapter 2 provides an overview of scrap metal operations in the United States and the characteristics of scrap metal from nuclear facilities. Chapter 3 describes the screening procedures used to define the scope of the analyses and discusses the limitations of these analyses. Chapter 4 describes the principal sources of scrap metal, which include the DOE complex and the commercial nuclear power industry.

Chapters 5 through 9 present a detailed analysis of the doses and risks to RME individuals from 44 radionuclides or nuclide combinations that may be present in three metals: carbon steel, aluminum and copper.

Chapter 5 describes the exposure scenarios used to assess the potential radiological impacts of the free release and recycle of carbon steel scrap on individual members of the public. (The term "members of the public" includes all individuals except radiation workers, whose exposures are governed by existing NRC and DOE regulations.) Chapter 6 presents the methodology and models used to perform these radiological assessments. Chapter 7 discusses the key results of

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detected and assayed in terms of their activities, not in terms of their masses, specific activity is a more useful concept

the assessments of carbon steel scrap. Chapter 8 describes the exposure scenarios and methods used to assess the radiological impacts of the free release and recycle of aluminum scrap and discusses key results of these assessments. Chapter 9 presents a similar discussion of the free release and recycle of copper scrap.

Volume 2 consists of six appendices. Appendix A presents a discussion of the scrap metal that would be generated by the decomissioning of commercial nuclear power plants in the United States This appendix includes a detailed analysis of carbon and stainless steel that would be available for potential release—the metals that constitute well over 90 percent of the metal inventory used to construct a nuclear power plant—as well as discussions of nine other metals. Appendix B presents a detailed discussion of aluminum recycling, beginning with an analysis of the potential availability of aluminum scrap from nuclear facilities, continuing with an overview of aluminum recycling, and concluding with a series of possible scenarios for assessing the radiological impacts on potentially exposed individuals. Appendix C presents a similar discussion of copper scrap. Appendix D presents a review of published reports, data bases, and computer codes which formed the basis for selecting the radionuclides addressed in the analysis. Appendix E presents the empirical and scientific basis for determining how various trace elements and their compounds are redistributed among the various phases during the melt-refining of carbon steel. Appendix F presents a similar discussion related to the production of cast iron.

Volume 3 contains six more appendices. Appendix G discusses the geographical and temporal distribution of anticipated future releases of carbon and stainless steel from commercial nuclear power plants, and the possible sites for the melt-refining of these materials and the processing of the baghouse dust, a byproduct of melt-refining. Appendix H presents a detailed discussion of the data sources and parameters used to construct the exposure scenarios described in Chapter 5. Appendix I discusses the empirical data on the leaching of contaminants from steel slags and presents a model for estimating the leach rate of trace elements. Appendices J and K present the detailed results of the radiological assessments of individuals potentially exposed to each radionuclide by exposure scenario and pathway. Appendix L presents an analysis of the radiological impacts on the RME individual if steel scrap that is free-released from a nuclear facility were buried in a RCRA Subtitle D solid waste landfill, and an assessment of the burial of aluminum dross in a similar landfill.

REFERENCE

Industrial Economics, Inc. (IEC). 1997. "Radiation Protection Standards for Scrap Metal: Preliminary Cost-Benefit Analysis." Prepared for U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, Washington, DC.